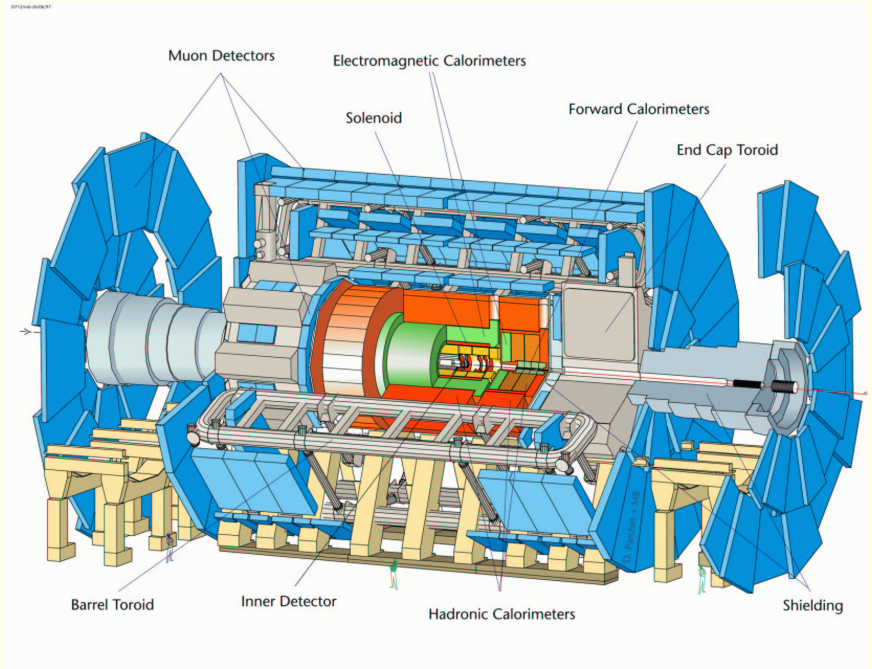
ATLAS – Computing and Physics

Ian Hinchliffe LBNL



November 7, 2005

Berkeley Lab

Software and Physics

- Core software activities
- Inner detector software
- Physics activities

Significant increase in Physics manpower on software related activities since June 2005: New postdocs and students, migration from CDF and hardware.

Data is coming

Cosmic ray running has started

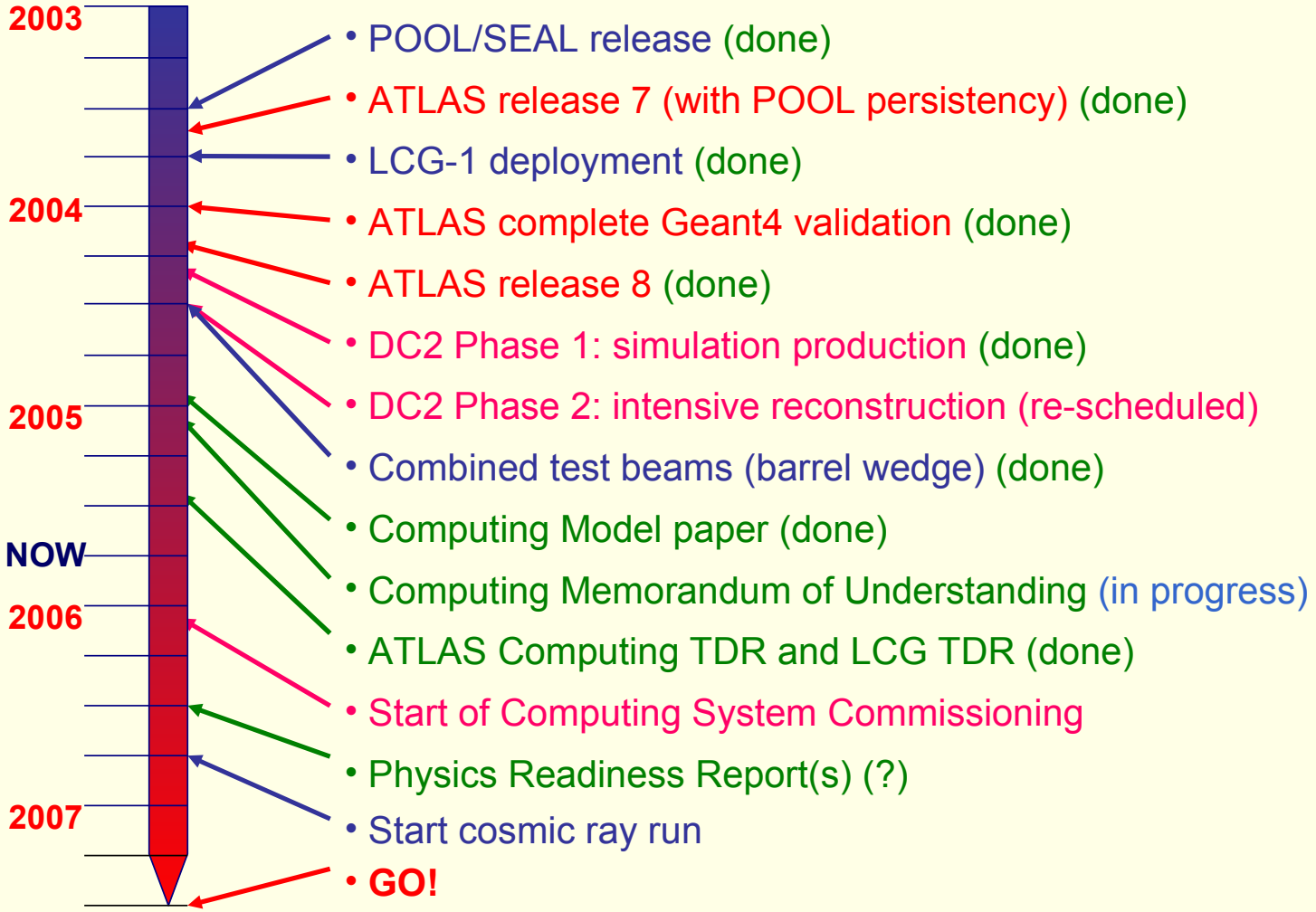
At luminosity of 10^{33} cm^{-2} sec^{-1}

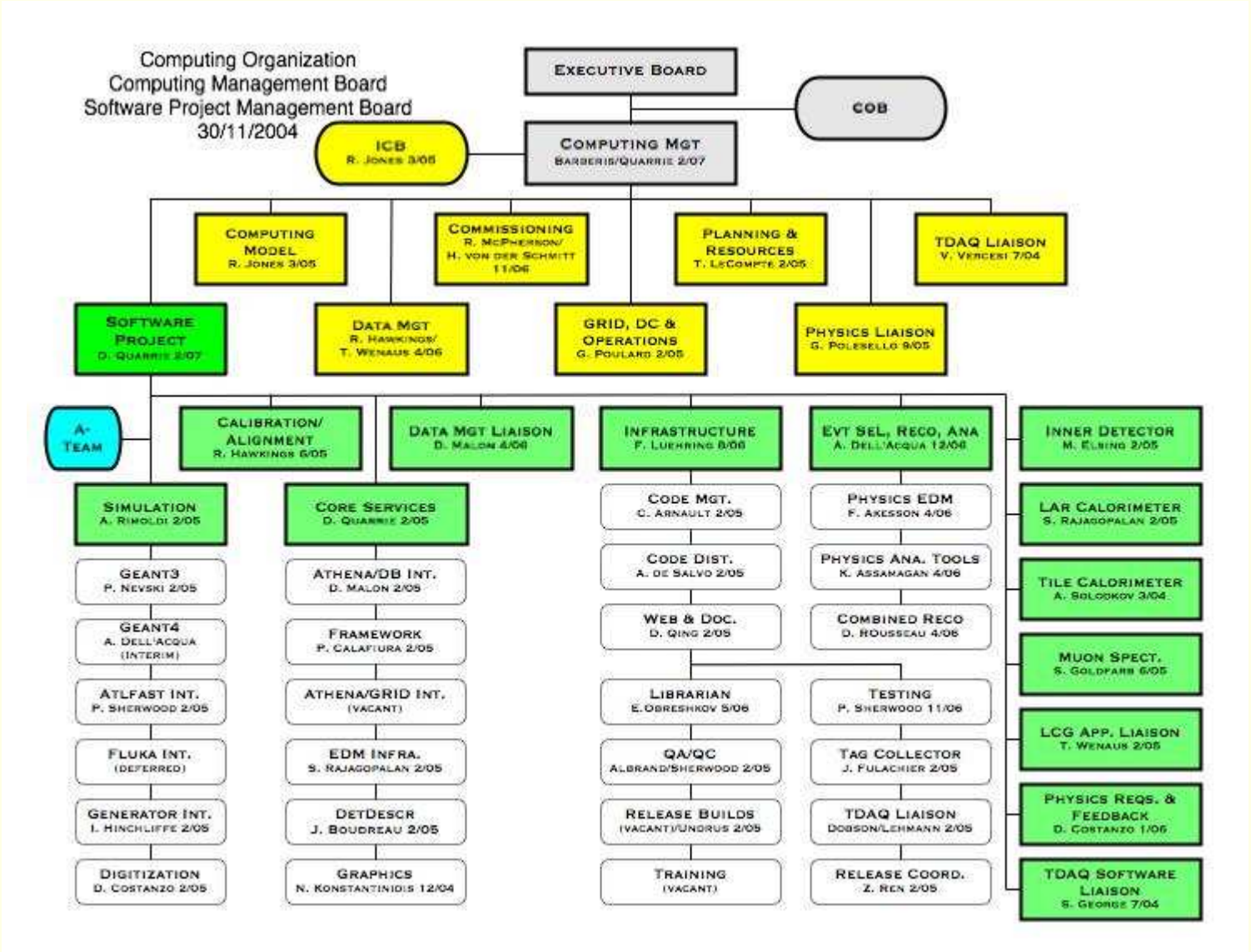
Process	$\sigma(nb)$	rate	Events/year
min bias	10^8	100 MHz	$\sim 10^{15}$
top	0.85	0.85 Hz	$\sim 10M$
$Z \rightarrow \mu^+\mu^-$	1.5	1.5	$\sim 10M$
$W \rightarrow e\nu$	15	15	$\sim 100M$
jets with $p_T > 200$ GeV	1000	1000	$\sim 1000M$
WW pairs	0.08	0.08	$\sim 1M$
ZZ pairs	0.011	0.011	$\sim 12k$

100 pb^{-1} will extend new physics reach beyond Tevatron

LBNL work to understand which early data will be used for alignement:jets, Drell-Yan etc

Core software– 1




Computing Organization
Computing Management Board
Software Project Management Board
30/11/2004
EXECUTIVE BOARD
COB
ICB
R. JONES 3/05
COMPUTING MGT
BARBERIS/QUARRIE 2/07
COMPUTING MODEL
R. JONES 3/05
COMMISSIONING
R. MCPHERSON/
H. VON DER SCHMITT
11/06
PLANNING & RESOURCES
T. LECOMPTE 2/05
TDAQ LIAISON
V. VERCESI 7/04
SOFTWARE PROJECT
D. QUARRIE 2/07
DATA MGT
R. HAWKINGS/
T. WENAUS 4/06
GRID, DC & OPERATIONS
G. POULARD 2/05
PHYSICS LIAISON
G. POLESELLO 9/05
A-TEAM
CALIBRATION/ ALIGNMENT
R. HAWKINGS 6/05
DATA MGT LIAISON
D. MALON 4/06
INFRASTRUCTURE
F. LUEHRING 8/06
EVT SEL, RECO, ANA
A. DELL'ACQUA 12/06
INNER DETECTOR
M. ELSING 2/05
SIMULATION
A. RIMOLDI 2/05
CORE SERVICES
D. QUARRIE 2/05
CODE MGT.
C. ARNAULT 2/05
PHYSICS EDM
F. AKESSON 4/06
LAR CALORIMETER
S. RAJAGOPALAN 2/05
GEANT3
P. NEVSKI 2/05
ATHENA/DB INT.
D. MALON 2/05
CODE DIST.
A. DE SALVO 2/05
PHYSICS ANA. TOOLS
K. ASSAMAGAN 4/06
TILE CALORIMETER
A. SOLODKOV 3/04
GEANT4
A. DELL'ACQUA
(INTERIM)
FRAMEWORK
P. CALAFIURA 2/05
WEB & DOC.
D. QING 2/05
COMBINED RECO
D. ROUSSEAU 4/06
MUON SPECT.
S. GOLDFARB 6/05
ATLFAST INT.
P. SHERWOOD 2/05
ATHENA/GRID INT.
(VACANT)
LIBRARIAN
E.OBRESHKOV 5/06
TESTING
P. SHERWOOD 11/06
LCG APP. LIAISON
T. WENAUS 2/05
FLUKA INT.
(DEFERRED)
EDM INFRA.
S. RAJAGOPALAN 2/05
QA/QC
ALBRAND/SHERWOOD 2/05
TAG COLLECTOR
J. FULACHIER 2/05
PHYSICS REQS. & FEEDBACK
D. COSTANZO 1/06
GENERATOR INT.
I. HINCHLIFFE 2/05
DETDESCR
J. BOUDREAU 2/05
RELEASE BUILDS
(VACANT)/UNDRUS 2/05
TDAQ LIAISON
DOBSON/LEHMANN 2/05
TDAQ SOFTWARE LIAISON
S. GEORGE 7/04
DIGITIZATION
D. COSTANZO 2/05
GRAPHICS
N. KONSTANTINIDIS 12/04
TRAINING
(VACANT)
RELEASE COORD.
Z. REN 2/05

Core software– 2: LBL current issues

- Quarrie is software project leader
- Gaudi "core" is a joint project with LHCb: Leggett is responsible for Atlas-Gaudi
- Calafiura heads atlas framework.
- Usability: Emphasis on "making software user. friendly (Calafiura, Woudstra)
- Performance: Profiling to understand bottlenecks particularly in user analysis (Lavrijsen)
- Grid integration (Woudstra)

LBNL is the lead ATLAS group in this area

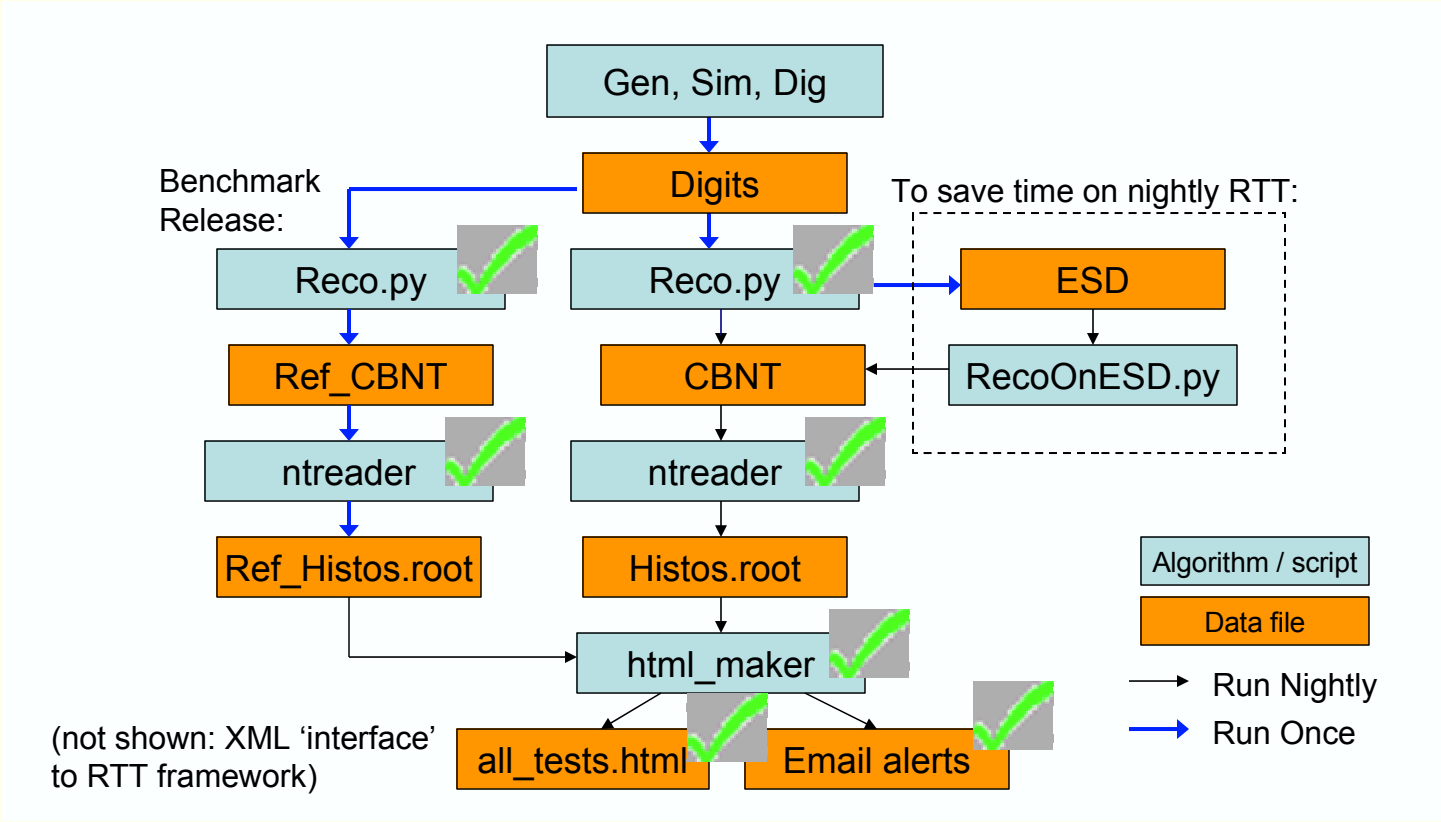
This needs a 1 hr talk to do it justice, therefore I move on...

Software validation – RTT (run time testing)

New activity aimed at understanding and monitoring inner detector reconstruction software

Vahsen, Zenz, Gaponenko

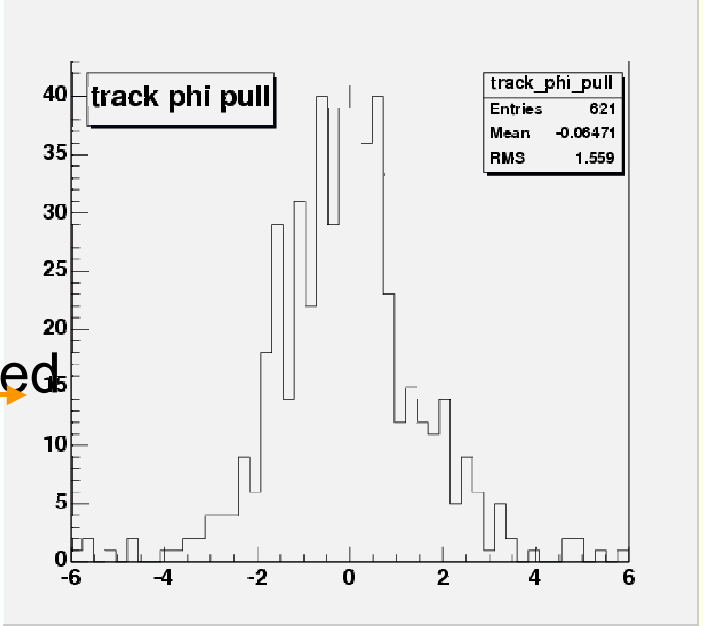
- Produce tools to compare track reconstruction in nightly build with benchmark release
- Use existing UCL Run Time Tester system
- Automatic webpage of comparison output
- Automated emails if there are changes, since these need to be understood!
- Expand involvement to larger-scale testing and active improvement of tracking software


Gen, Sim, Dig
Digits
Benchmark Release:
To save time on nightly RTT:
Reco.py
Reco.py
ESD
Ref_CBNT
CBNT
RecoOnESD.py
ntreader
ntreader
Ref_Histos.root
Histos.root
Algorithm / script
Data file
html_maker
Run Nightly
Run Once
(not shown: XML 'interface' to RTT framework)
all_tests.html
Email alerts

some example plots, just to show that it works

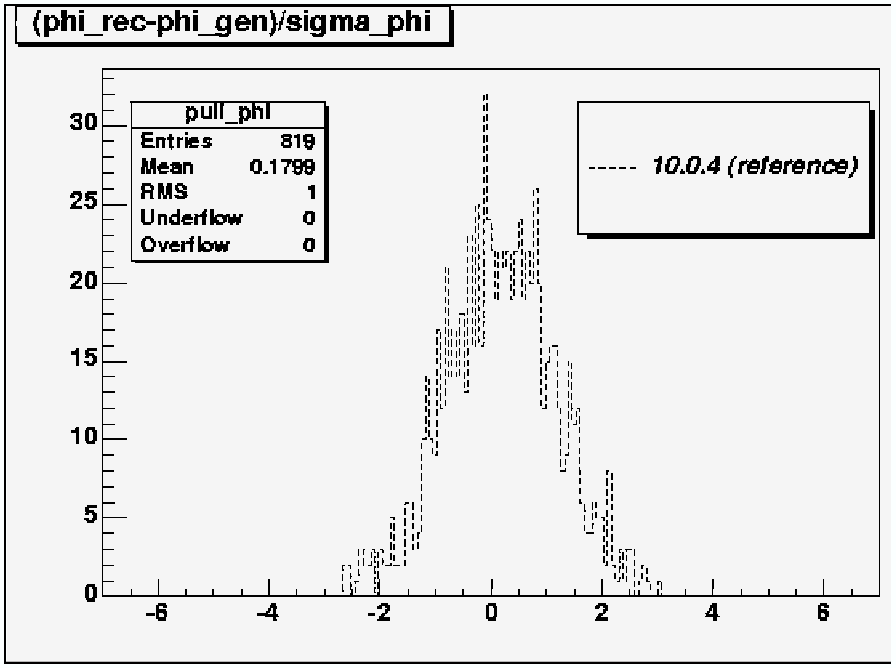
```
n3->Draw("track_phi-track_truth_phi)/track_error_phi");
```

- phi pull distribution (using reconstructed tracks and best hit-matched truth track)



Inner Detector Tracking Histogram "mc2rec_cuts_pull_phi"

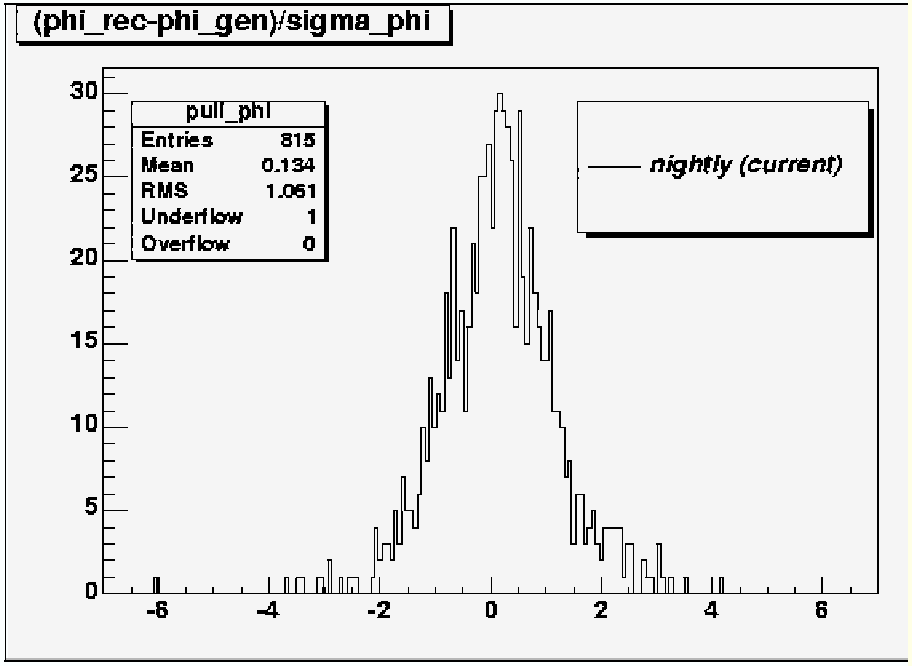
Test performed	Result	Pass/Fail
Is the histogram mean consistent with zero?	fabs(mean/sigma_of_mean)=5.148603 (cut was 4.000000)	FAIL



This page was automatically generated on Wed Sep 14 00:55:24 2005 .

Inner Detector Tracking Histogram "mc2rec_cuts_pull_phi"

Test performed	Result	Pass/Fail
Is the histogram mean consistent with zero?	fabs(mean/sigma_of_mean)=3.603895 (cut was 4.000000)	PASS



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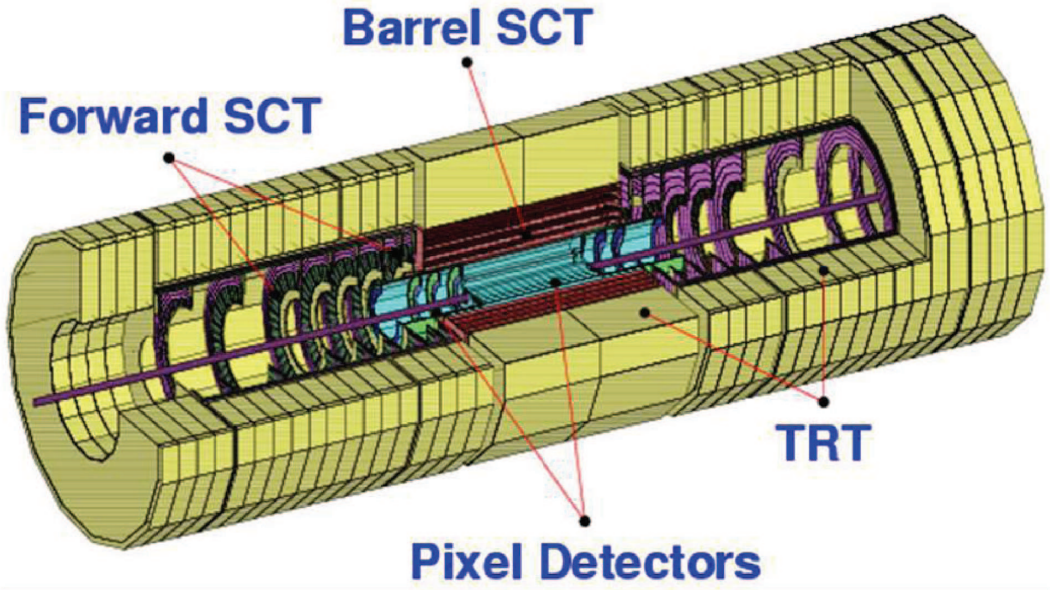
Pixel Alignment work

Golling, Madaras...

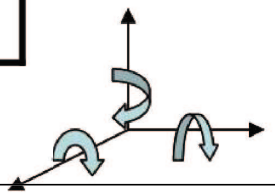
- Atlas ID alignment strategy in its infancy
- Start using survey data on modules (made at LBL) as contraints in alignment
- Can, for example, use overlaps between modules for local alignment

Silicon = Pixel + SCT



	Barrel		Forward	
Detector	PIX	SCT	PIX	SCT
# of layers/disks	3	4	2x3	2x9
# of modules	1456	2112	2x144	2x988
sub Total	3568		2264	
Total	5832			

3 translations
& 3 rotations
of each module



In total we have to deal with 34,992 DoF's!

Survey of Modules

Why survey?

To get the best description of the as-built geometry of the detector device (i.e. the modules)

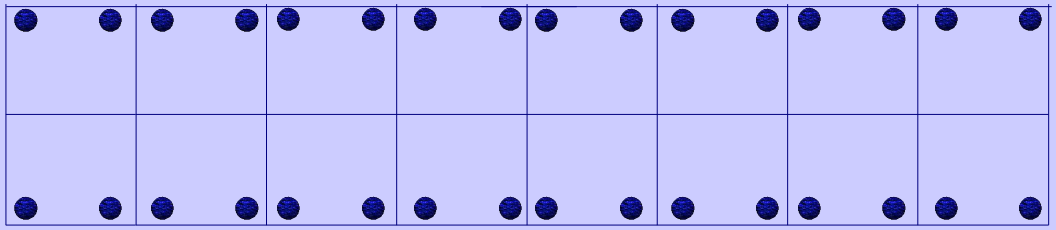
⇒ Alignment

How is survey done?

Use an optical alignment machine (SmartScope) and measure the position of 16 points on each (long) side of the module (=32 measurements/module)

Survey on sector and again on disk

- Measure position of module on sector
- Measure position of sector on disk



Sketch of module:

- 16 measurements on each side (on chips - sensor not visible!)
- not equidistant!

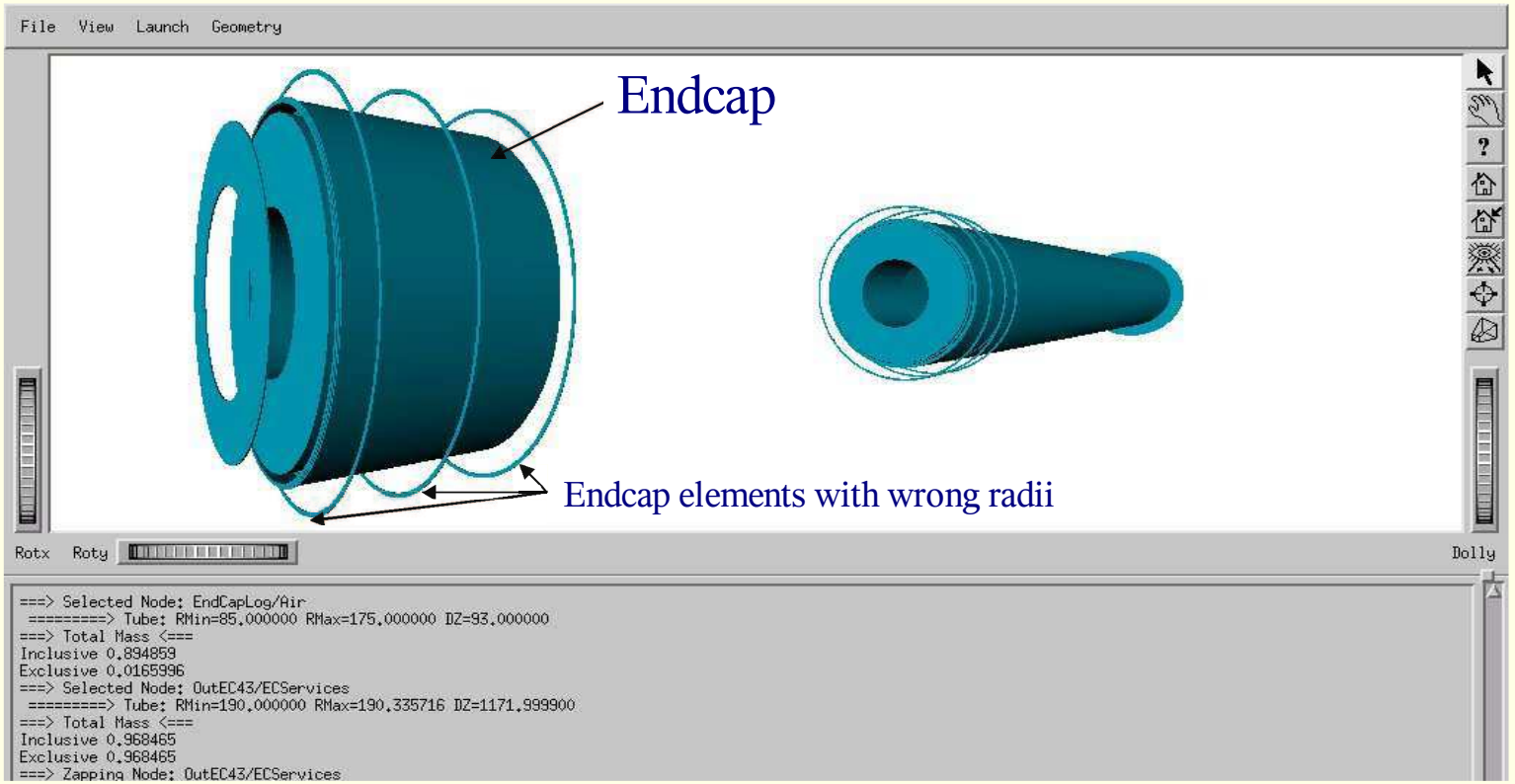
Pixel disk Geometry description

Zdrazil, Gilchriese

- Part of "as installed geometry" for CSC (later)
- Must capture knowledge from construction into Atlas Geometry model (GeoModel)
- Accurate materail map is essential: current simulation geometry not correct
- ATLAS goal is 1%

End Caps in GeoModel

- Endcap = three disks, associated cooling pipes and services, endframe, pixel supports, interface of end cap to beam pipe support = deliverable item from LBNL
- Does not include PP0, PST, etc.



GeoModel versus Weights

Item	GeoModel Name	GeoModel Weight	Measured Weight	Measured-GeoModel	Comments
Modules	HybridECLog,ChipECLog,SiLog	245	266.4	21	Does not include glue to sectors
Disk Supports 1	DiskSupLog0	9.3			
Disk Supports 2	DiskSupLog1	248.4			
Disk Supports 3	DiskSupLog2	131.4			
Subtotal: Bare Sectors		389.1	480	91	Rough estimate, need better subtraction of tubes and fittings
DISK 1,2,3 RING SUPPORT	InEC0, InEC1, InEC2	242.4	473	231	Rings+3 sector bolts
EC cables	ECCableLog/ECCables	4.7			
DISK 1,2,3 SERVICE	OutEC1(3,5)	8.7			
DISK 1,2,3 COOL CAB (TUB+SIG/POW RIBB)	OutEC55,OutEC57,OutEC59	12.6			Radial extent of this is wrong in GeoModel
Subtotal: Radial Type0		26.0			
DISK 1,2,3 1ST AXIAL SEG	OutEC7(9,11)	12.39			
DISKS 1,2,3 COOL MANIFOLDING + CONN	OutEC13(15,17)	194.7			
DISKS 1 COOL MANIFOLDING (2ND)	OutEC21	1.67			
DISKS 2 COOL MANIFOLDING (2ND)	OutEC19	2.34			
DISKS 3 COOL MANIFOLDING (2ND)	OutEC23	1			
COOL CAB FOR DISKS 1	OutEC25	74.16			
COOL CAB FOR DISKS 2	OutEC27	37.33			
COOL CAB FOR DISKS 3	OutEC29	7.64			
COOL CAB FOR DISKS 1	OutEC31	0.82			
COOL CAB FOR DISKS 2	OutEC33	1.23			
COOL CAB FOR DISKS 3	OutEC35	1.62			
COOL CAB FOR DISKS 1	OutEC37	33.13			
COOL CAB FOR DISKS 2	OutEC39	32.57			
COOL CAB FOR DISKS 3	OutEC41	32			
Subtotal: Tubes/Fittings + Type0		458.6	985.6	527	Includes piece of sector tube/fittings, no liquid in measured
PIX-PST INTERFACE 100G TI	OutBrl49	102	77	-25	
OVERALL PIX SYS SUP(2ND)	OutBrl29	432			
OVERALL PIX SYS SUP COMPENS FOR HOLE	OutBrl31	47			
Subtotal: Frame		479	883	404	Frame + bolts
DISK END PIECES	OutEC61	125	223	98	Endplate+bolts
Missing items					
TROLLEY MOUNTS			33	33	
STRAIN RELIEF BRACKETS+BOLTS			97	97	
	TOTAL	**2041**	**3518**	**1477**	**For one endcap**

Event Simulation

- G. Savropoulous is primary ATLAS person with responsibility for Event Generation tools
- Maintains, Pythia, Herwig, Jimmy, Alpgen,Sherpa and MCAtNLO.
- Maintains core software for all event generators

Data production for Rome Physics workshop (June 2005)

- Run by IH and Davide Costanzo (left LBL Feb 2006)
- Emergency situation following delays in DC2
- Approx 8M events simulated by Geant-4
- First large scale use of Grid: many lessons learned
- More than 50% of presentations in Rome used the data.

Rome physics workshop

- http://agenda.cern.ch/fullAgenda.php?ida=a044738
- Start of serious thinking about data
- first large scale use of software by physicists

Data access strategies

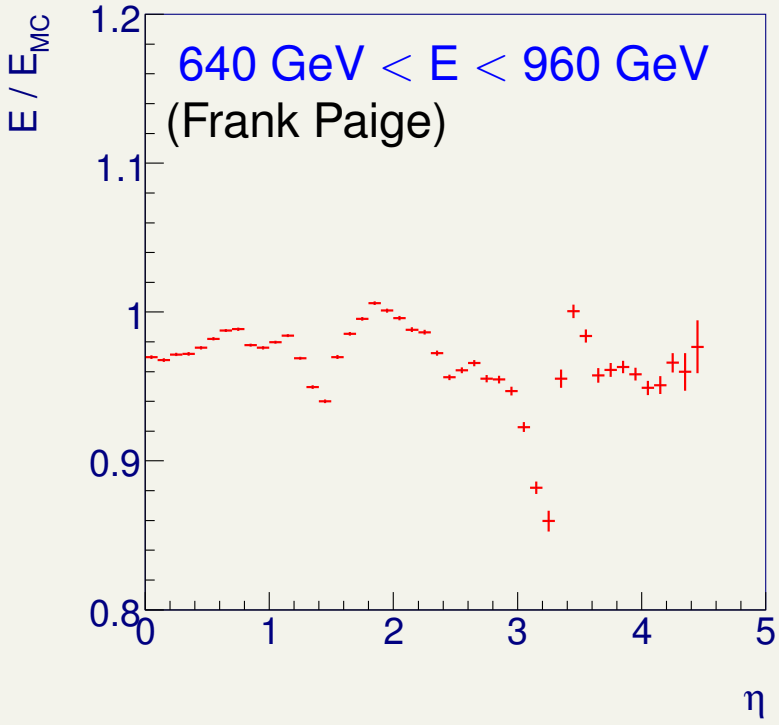
- Reconstructed data appears as ESD (event summary data) and AOD (analysis object data)
- ESD is (~ 2 Mby/event) contains all information
- AOD (~ 100 Kby/event) is where most physicists work
- Navigation is possible between ESD and AOD (assuming both available locally)
- Rome workshop provided first large scale test of this http://agenda.cern.ch/fullAgenda.php?ida=a044738
- serious performance issues discovered

SUSY work for Rome Physics workshop

- Basic analysis code provided by (IH Costanzo): extensively developed by Paige (BNL) and used by entire group and by some other groups

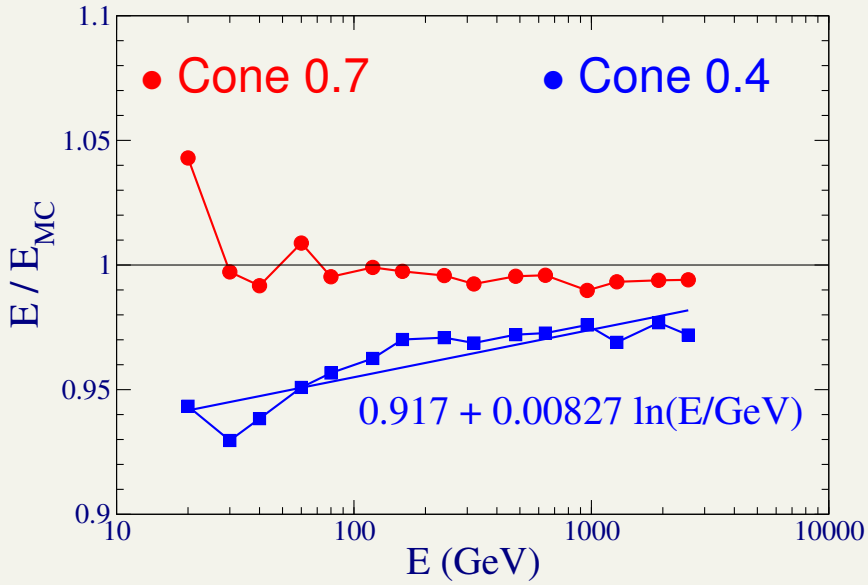
Jet Reconstruction in SUSY events (Point SU1)

Different Jet reconstruction algorithms
(Cone 0.4, Cone 0.7, K_T)



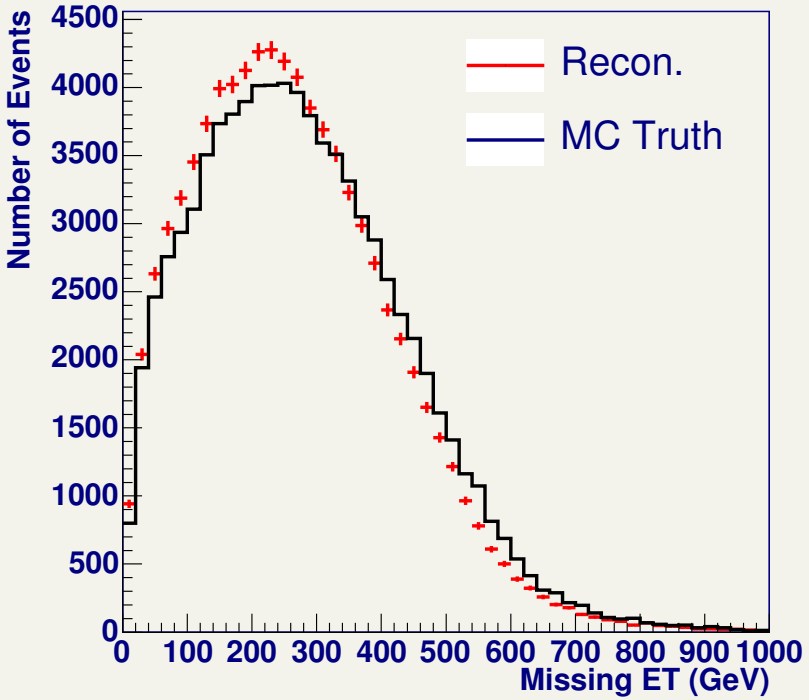
Same algorithm used to cluster both Calorimeter Towers and MC Truth

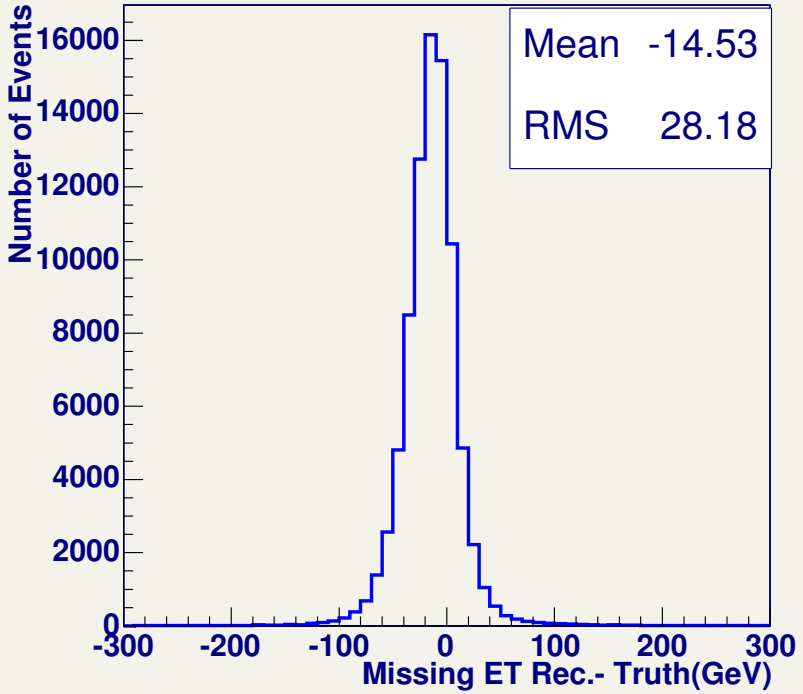
Match Reconstructed and MC truth jets in ΔR and compare their energy



Missing E_T Reconstruction (SU3 point)

Compare $\not\!\!E_T$ from Reconstruction and MC Truth
(Nurcan Ozturk)





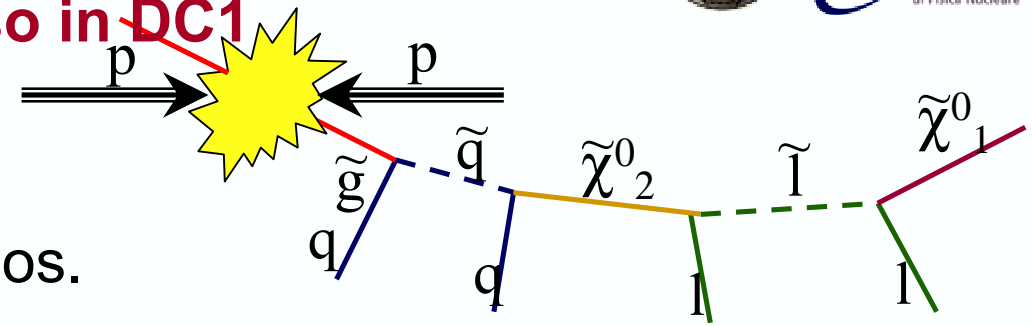
10 ÷ 20 GeV Shift Observed in all the samples.

SU3: Di-lepton inv. mass

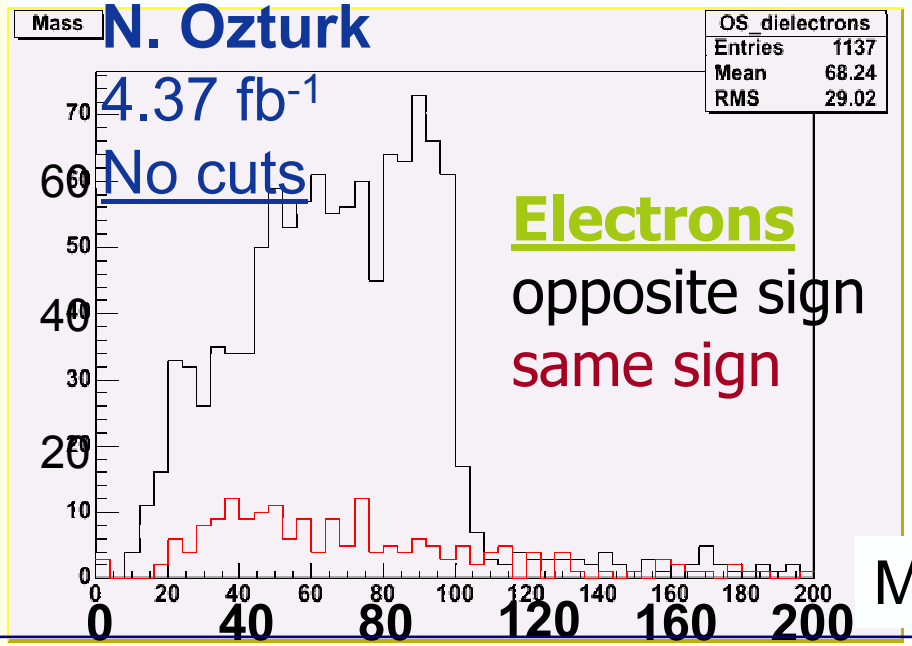
Bulk model, studied also in DC1

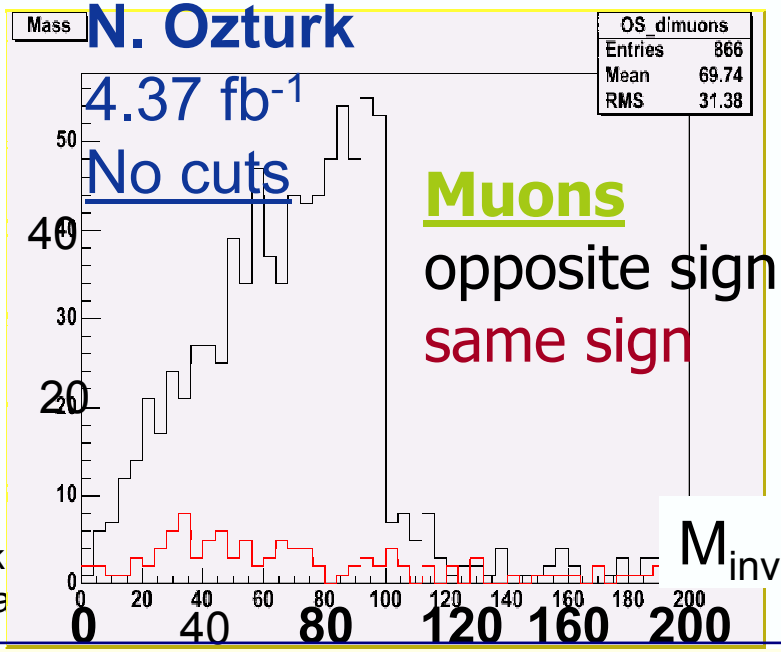
In most scenarios the **first SUSY decay** reconstructed is leptonic decay of neutralinos.

"Smoking gun" is excess of opposite-sign lepton pairs with an edge structure in invariant mass



$$M_{ll}^{\max} = M(\tilde{\chi}_2^0)\sqrt{1-\frac{M^2(\tilde{l}_R)}{M^2(\tilde{\chi}_2^0)}}\sqrt{1-\frac{M^2(\tilde{\chi}_1^0)}{M^2(\tilde{l}_R)}} = \mathbf{101.31\ GeV}$$





B-tagging in SUSY events

S. Vahsen- LBL

.

Many new particles will decay to b-quarks

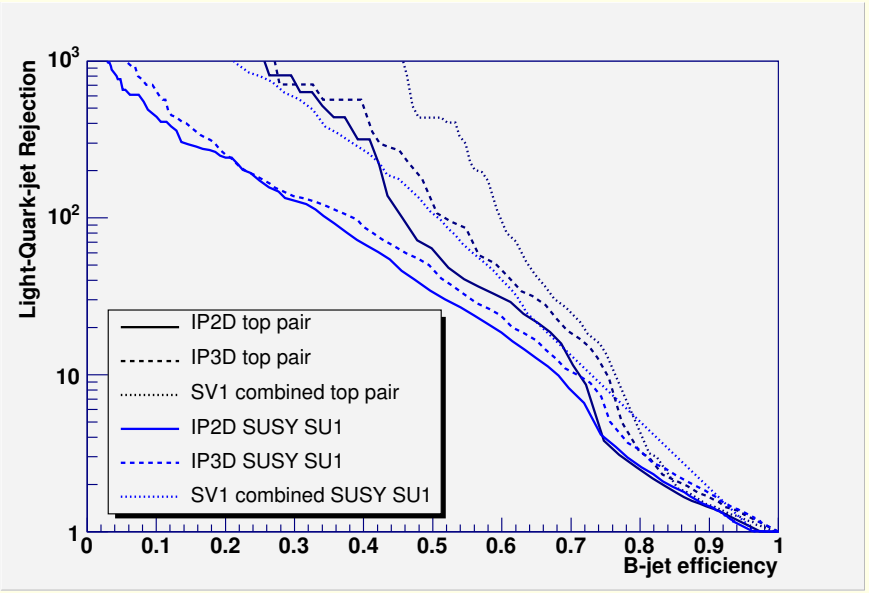
Therefore identification of jets from b-quarks is vital

Looked for tracks with finite impact parameter $c\tau \sim 100\mu m$

Figure of merit is efficiency vs rejection against other jets

Supersymmetry events are very complex

Plot shows current performance compared to top events



Looking ahead – Computing System Coomissioning (CSC)

Last major software test before real data

- Physics data production (Coordinator:I Hinchliffe):L 10M+ event to represent "early data"
- Data definition underway now
- Data will be use for full software test in 2006:
- Based on "as installed" geometry.
- Full production early 2006
- Later: misaligned sample to all enable $e.g.$ full calibration/alignment test

CSC Tests

- Sub-system tests with well-defined goals, preconditions, clients and quantifiable acceptance tests
  - Full Software Chain
    - From generators to physics analysis
  - Tier-0 Scaling
  - Calibration & Alignment
  - Trigger Chain & Monitoring
  - Distributed Data Management
  - Distributed Production (Simulation & Re-processing)
  - (Distributed) Physics Analysis
  - Integrated TDAQ/Offline
- Each sub-system is decomposed into components
  - E.g. Generators, Reconstruction (ESD creation)
- Goal is to minimize coupling between sub-systems and components and to perform focussed and quantifiable tests

David R. Quarrie: Computing System Commissioning

Others

- Luminosity task force: report due Feb 2006: M Shapiro (chair)
- Computer Model Group: ongoing: I Hinchliffe (member)
- Monte Carlo Truth task force: reported 30 Oct 2005: I Hinchliffe (member)
- Reconstruction software review: reported August 2005: I Hinchliffe (member)
- Atlas software useability task force: Calafiura (member)
- US ATLAS Task Force on analysis support: Hinchiffe and Gilchriese (members)

Regional activities

US ATLAS Task Force. Recommended setting up three analysis support centers based at BNL, ANL and LBNL

First meeting on October 21: 54 attendees from SLAC, Irvine, Oregon, Oaklahoma U, New Mexico, Arizona, Santa Cruz, Washington

Arranged by Loken; 11 talks (6 from LBNL)

http://agenda.cern.ch/fullAgenda.php?ida=a056605

Joint Tier 2 proposal with SLAC soon.

Conclusions/Messages

- Accelerator and Detectors approaching completion
- Huge effort needed to get software working in time for physics in 2007
- Must be fully focused on this
- LHC is first new energy frontier in a generation
  "Our field may be toast if we fail to fully exploit it"
- Back to work....